THE PILOT

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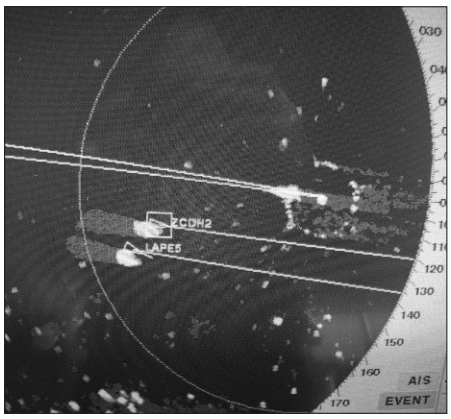
The official organ of the United Kingdom Maritime Pilots' Association

Automatic Identification System (AIS) TRANSPONDER UPDATE



"Virtual" ...

It is now just over one year since AIS became mandatory for all SOLAS vessels over 300 grt and although I must admit that my prediction that the system would have difficulty in coping with the amount of traffic in port areas has been largely proven wrong there are increasing cases of ships' units failing in a variety of functions. These failures are about to gain in significance as a result of the implementation of Class B AIS for non SOLAS vessels and, from 1st July 2008, the requirement for new radars to have AIS integration. It is therefore timely to identify some of the problems that are occurring with the existing systems.

... "Reality"

Editorial

The good news this quarter is that the UKMPA is at last going to be represented within the group Port Skills and Safety Limited (PSSL). PSSL took over from the DfT funded British Ports Industry Training (BPIT) in 2002 and whereas the UKMPA had worked closely with BPIT to produce a comprehensive document detailing National Occupational Standards for Maritime pilots we were not invited to join the port led commercial body of PSSL. It has therefore taken four years of hard work by both Norman McKinney and Les Cate along with members of the Section Committee to finally achieve an invitation to participate on the group's activities relevant to pilots. The reason that this is important is that PSSL, in conjunction with some nautical colleges, have produced a draft Foundation Degree for ports which will include pilotage and it is therefore essential that pilots are represented. The UKMPA has only one agenda within PSSL and that is safety and we will therefore be using our membership to convince those who may wish to reduce standards that it is in the interests of the whole ports sector that high standards of training and qualifications for pilots are maintained in the interests of ensuring the safety of ships, port infrastructure and reputations!

John Clandillon-Baker

I am aware of three cases where total failure has resulted in vessels having to either send their units away for repair or having to install a replacement set. This has meant that until the AIS was repaired or replaced the vessels concerned were navigating without AIS and were thus invisible to AIS tracking systems. With respect to other failures the most common on-board malfunction is the misalignment between the gyro heading and the AIS heading which results in the AIS heading either defaulting to North or the AIS heading being incorrectly aligned. In the latter case this sometimes results from the unit being switched off in port and if the heading is different when the unit is switched on again it does not automatically align with the correct heading but defaults to north or retains the original shut down heading. Unfortunately, such faults are not readily apparent to those on board and are usually only identified by reports from other vessels or a VTS centre. Fixing this alignment problem is also not straightforward on many vessels and I have recently piloted a vessel where it was necessary to contact a service technician to resolve this error. As experience is gained then these faults should normally be eliminated by including the AIS gyro heading alignment on the pre sailing check list, but there is now a new problem with this in that since the only training that most officers have received is from the installation engineer, when new crews join who are unfamiliar with a particular AIS unit they may have no idea how to undertake some operational procedures. This may seem an unlikely scenario, but I was on one vessel recently which was reported as having misaligned heading data and the gyro alignment interface was a via a small separate unit with an adjustment dial tucked away underneath the wheelhouse console. Fortunately the Mate had witnessed the installation, but this is not the sort of detail that would normally

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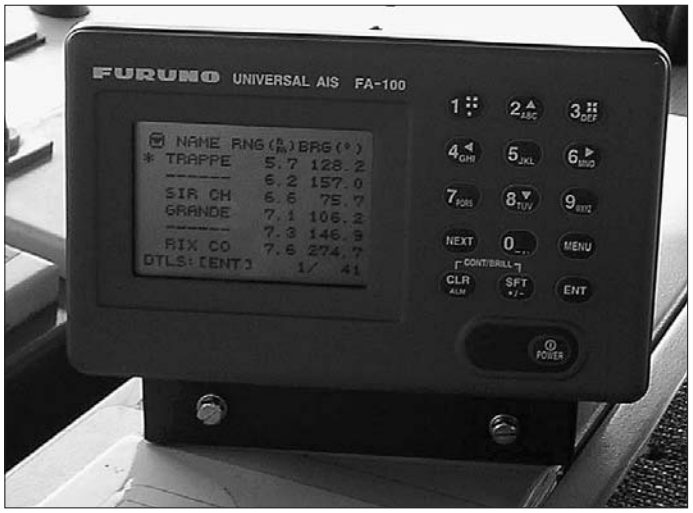


Picture 1. Two of our ships are missing!

be passed on during the usual few hours of a crew change! All this of course does raise the point that surely in the 21st century, technology should be able to eliminate such tedious and fiddly operations!

Another problem which I have observed on some ships' AIS is the phenomena whereby AIS data either disappears ***(picture 1)*** or the data defaults to the basic MMSI number. Because these effects are not universal (other vessels and VTS are tracking the "missing" target without problems) I have been advised that such target corruption is most likely to be caused by poorly installed equipment. However, and this is a problem that may become serious with the introduction of the Class B AIS, such target loss could also be caused by what is termed as "garbling" of the signal. It is therefore of relevance to be aware as to how garbling may arise and the following explanation is from a paper presented to the Royal Institute of Navigation NAV05 Conference by Dr Andy Norris who chairs the Technical Committee of the International Electrotechnical Committee (IEC) that is responsible for issuing technical standards for ships' radio and navigation equipment:

AIS works on Time Division Multiple Access (TDMA) transmissions. The basis of TDMA is that time is divided up into discrete 'slots' and only one station (base-station, ship-station, etc) will be transmitting during a particular time slot. For AIS there are 2,250 slots in every minute on each of the two AIS VHF channels, which are known as AIS 1 and AIS 2. UTC is used as the time reference. When an AIS Class A station is first switched on it pre-determines its transmission slots by 'listening' to the existing traffic. This establishes which slots are free, helped by stations already 'on-air', which broadcast their future slot selection as part of their transmitted messages. The fact that each station determines its own slots within an organised regime gives this technique the name 'Self Organising TDMA' (SOTDMA). In busy areas unused slots become rare and then stations select slots already in use by the most distant stations. These are readily calculated because of the positional data contained within the AIS messages. The organised reuse of slots from distant stations should make AIS degrade "gracefully" as the number of stations in an area increases by making the effective range of AIS decrease to match the increase in station density. The characteristics of the frequency modulated (FM) signal used by AIS helps in ensuring that the strong signals from close stations are properly demodulated in the presence of weaker signals from more distant stations sharing the same slot. This is known as co-channel interference rejection. However, if confronted with signals of similar strength the demodulator becomes confused and 'garbling" occurs. In fact there are a number of mechanisms that can make signals from distant stations similar in strength or even stronger than some closer stations. For instance, poorly situated AIS antennas can cause 'masking' in some directions and enhanced sensitivity in other directions. Also, anomalous propagation of VHF signals during particular climatic conditions can provide a focusing effect, giving even very distant stations unusual prominence. For these reasons the inbuilt features of SOTDMA do not always ensure that closer stations are received in preference to more distant stations.

Practical Useage

With respect to the type of equipment installed, the overwhelming majority of vessels are fitted with the minimum required to comply with carriage regulations! These are small alpha numeric displays which at the absolute basic level have to display at least three targets. I have seen such minimal three line units on ships and for all practical purposes they are totally useless. Other systems cram a list of many targets into the small display (typically 9cm x 12cm) which renders them illegible and again these are totally useless. The more sophisticated units, such as those manufactured by SAAB and SAILOR, are fortunately the ones most commonly fitted but due to the small screen size these also have severe practical limitations in areas where several ships are present, which of course is when it is likely to be of most benefit! These intermediate sets offer a choice of display modes, with either a list of targets being displayed or a by a graphic display similar to a mini radar picture. On the graphic display ***(picture 2)***, selecting a target for display is so fiddly that again it is impractical and in my experience around 90% of vessels have the display set to the list mode.

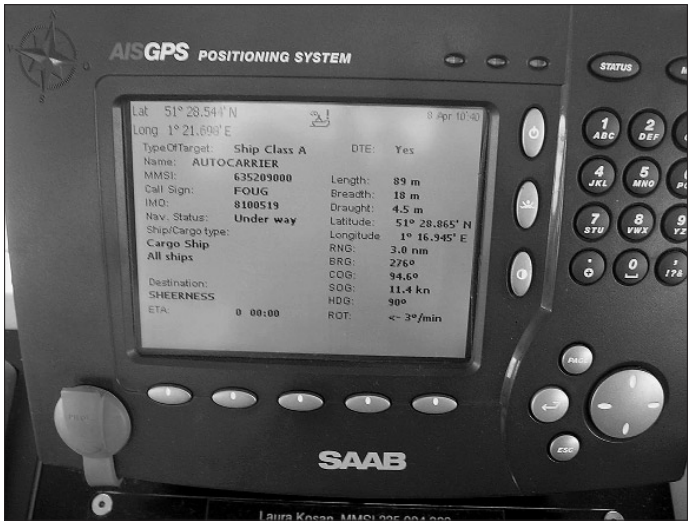
Picture 2. Selecting targets on the graphic display is fiddly

Picture 3. The target list by range is the normal mode of use

Again there are several options for listing but the most useful is the target list selected by range ***(picture 3)*** which displays the MMSI number, the name of the vessel and its range and bearing. By scrolling down the list a target can be selected and extended data on the selected vessel can be obtained ***(picture 4)***. The obvious place for sighting such displays is adjacent to the radar where the bearing and rage of a radar target can be correlated with the AIS display and a good example is shown in ***picture 5***. However, on many vessels the AIS is sited wherever there happened to be some space when the set was delivered and this is usually remote from the radar and quite frequently in a corner at the back of the chart table! I have yet to come across any free standing AIS unit that has an integrated anti collision warning fitted should another AIS target enter a pre determined danger zone around the own vessel, although such alarms are usually present where AIS is integrated into the radar display.

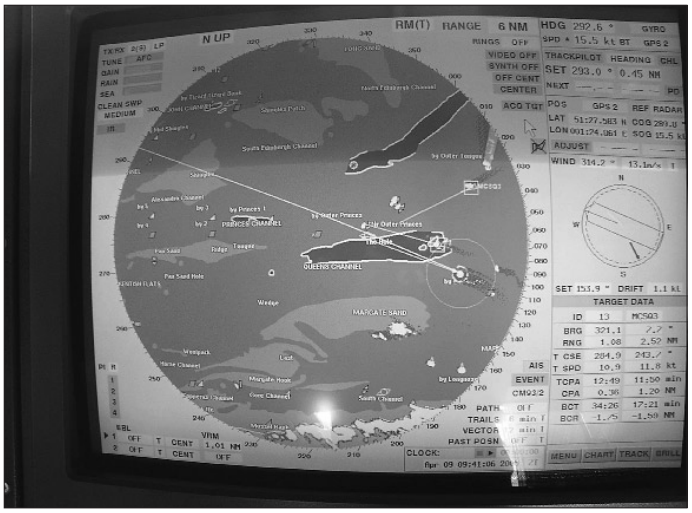
Integrated AIS on radar

The integration of AIS onto the radar display is being received with mixed enthusiasm by those on board using such systems and much depends on the quality of the equipment and its installation. ***Picture 6*** shows a high quality display which provided very accurate tracking with good correlation between the radar and AIS vectoring although even this equipment revealed some offset

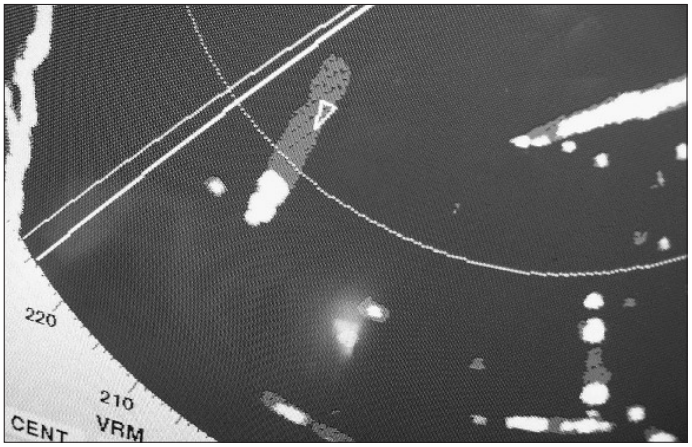


Picture 4. Extended data

Picture 5. ENC, Radar and IAS
(plus essential coffe mug - pink fluffy dice optional!)



Picture 6. Radar with AIS and chart overlay



Picture 7. Radar and AIS target offset. Approx. 2 cables!

between the radar and AIS targets ***(picture 7)*** and on other sets I have observed offsets of up to 5 cables and this is one aspect of integration which may cause a watch keeper to make an erroneous interpretation of a developing situation. Another particularly annoying "feature" of some AIS / radar integration displays is that although the AIS function can be switched off, many such displays that I have come across have had an automatic AIS proximity alarm which triggers if another AIS vessel enters the radar's anti collision guard zone. One unforeseen result of this supposed safety feature is that even when approaching a vessel at anchor or moored alongside, the AIS "collision" alarm resounds around the wheelhouse! The solution? The guard zone is set to zero and the alarms are set to "mute" thus neatly disabling one of the primary anti collision functions of the radar!!

One other fact is that I have yet to come across any Master or Officer of the Watch (OOW) who has been on an AIS course or received any formal instructions in its use. All knowledge on board has therefore either been gained from a brief introduction from the installation engineer or from the user manual. I believe (although I hope that I am proven wrong again!) that this lack of formal training is going to be a significant factor in vessel safety as Class B units and AIS radar integration displays are introduced. These two developments are designed to provide *"additional information to the OOW to enhance the situational awareness of a developing situation with respect to collision avoidance"*. This all sounds admirable but the limitations which have been placed on Class B AIS mean that both SOLAS and non SOLAS vessels may receive incomplete and inaccurate data! The reason for this is in the technical specifications of the Class B equipment and again the following is an edited extract from an article on AIS B implementation written by Dr Norris for the "Digital Ship" on-line magazine.

AIS B *offers leisure and other small vessel users a potentially valuable tool to enhance maritime safety at an affordable price. It has been designed to minimise degradation of the AIS network and will be available in three options.*

- *The basic unit is a display-less transmitter for up-mast mounting to alert the vessel's presence on SOLAS vessels' AIS in the same manner as a radar reflector does now on radar.*
- *Intermediate units have an inbuilt display (similar to the Class A displays) which, as well as broadcasting own-ship position, will enable users to see the positions and vessel data of all AIS-fitted vessels in their vicinity on the display.*
- *At the top end of the market AIS overlay capability will be added to radars and electronic chart systems, giving sophisticated navigational information to the user, vying with the facilities available on the most comprehensively fitted SOLAS vessel.*

With this prospect of eventual high usage in the leisure sector it is worthwhile taking a look at some of the possible issues that may arise with this increased use of AIS.

The Class B transponder transmits at a lower power (2 watts) than Class A (12.5 watts) thus reducing the effective range of Class B transmissions and their effect on the network. Also, position reports are given at a maximum rate of once every 30 seconds, as opposed to Class A systems, which typically transmit once every 10 seconds and up to every 2 seconds. Importantly, Class B systems will give priority to Class A transmissions, delaying their own transmissions if a Class A station is already transmitting. This is the fundamental aspect of the Carrier Sense (CS) mode of operation that is used by Class B. Tests have confirmed that the AIS network is minimally affected even if there are relatively large numbers of Class B vessels in any area.

Collision avoidance

AIS is considered to be a useful aid to improve situational awareness but its use as an anti-collision device is not recognised by the IMO.

The Collision Regulations (COLREGS) are written around the concepts of visibility (sight) of vessels and the proper use of radar and have not yet been revised to incorporate any reference to AIS. However, Rule 5 of the COLREGS (Lookout) does emphasise the use of 'all available means' to make a full appraisal of the situation and of the risk of collision. It therefore appears that this rule requires vessels that have AIS fitted to use the system as part of such an appraisal, but not to take collision avoidance decisions based solely on AIS data. What is fundamental is that AIS data should only be used with the full knowledge that data errors are possible and that not all targets may be transmitting data - an AIS system may not be fitted or a fault may have developed.

AIS displays

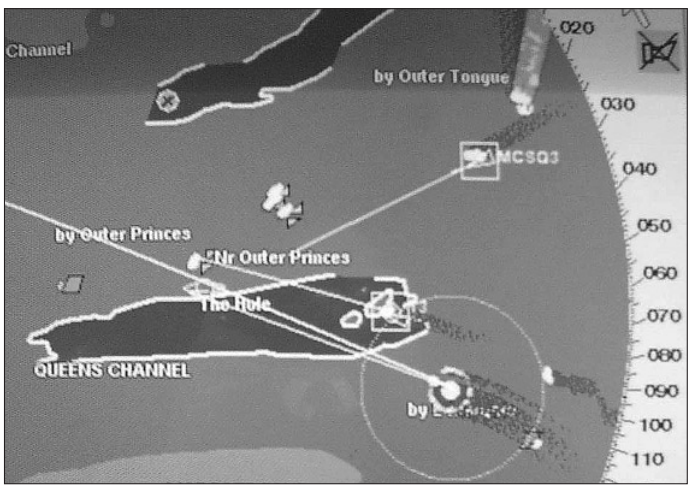
It is of extreme importance to the Class B user to be aware that there is no statutory requirement for SOLAS vessels to be able to display AIS targets on a screen merely a requirement to provide a simple alphanumeric Minimum Keyboard and Display (MKD). To meet the minimum requirements this display need show no more than three ships at any one time detailing bearing, range and name of ship. Therefore Class B users must understand that their vessel may not be appearing as a 'bright beacon' on the displays of the majority of SOLAS vessels. Although IMO requires all new radars fitted after 1 July 2008 to have good AIS display capabilities, existing radars will not have to be upgraded and so it will be many years before AIS data can be effectively used for navigation on many SOLAS vessels.

Unfortunately, an uninformed Class B user with a reasonable AIS display may base their own collision avoidance decisions solely on AIS data thus creating significant problems for SOLAS vessels.

Information overload?

The confusing excess of data when navigating in waters crowded with Class B users will render AIS useless for most Class A users fitted with the MKD. On a radar screen an excessive number of AIS symbols will make the observation of raw radar data more difficult and so the display of AIS targets may need to be inhibited or an AIS target filter enabled. From July 2008 all new navigation displays capable of showing AIS targets will need to meet IMO performance standards which require that AIS filters must be included 'in order to ensure that the clarity of the total presentation is not substantially impaired'. Increasingly sophisticated AIS filters may have to be developed but unfortunately it is difficult to make filters sufficiently adaptable to be effective whilst not obscuring possibly dangerous targets.

This article has highlighted some very relevant points and both the AIS B and radar AIS integration have the potential to create a dangerously confusing picture to the hapless navigator, especially in reduced visibility. I have previously identified a major problem with AIS integration on radar and the addition of Class B AIS into the already crowded display has the potential to create a nightmare scenario. In view of the fact that data update transmissions AIS B vessels are going to be at least 30 seconds apart and in busy areas may not update at all means that the information will be historic and therefore totally unreliable and this, coupled with an automatic collision alarm function has the potential to create so much information overload as to render the display unusable ***(picture 8)***. Dr Norris' article refers to filtering but correctly identifies the problem of actual dangerous targets then being missed. Couple this with the fact that leisure users are going to assume that they are being accurately plotted and carefully tracked by the professional navigators of the "bridge team" I don't believe that the word nightmare is at all inappropriate! As if these factors are not sufficiently worrying there is a also move by IALA, buoyed by an enthusiasm for e-navigation by the shipping Minister and DfT, to introduced AIS based "virtual" navigation marks to replace the traditional physical marks! Considering that the original full implementation date for AIS by IMO was December 2008, which was accelerated by four years following pressure from the USA's security agenda, I personally feel that the AIS has been implemented without a proper assessment of the practical useage through structured operator feedback and to now release the system into the leisure



A developing situation.
Will the inclusion of Class B AIS result in information overload?

market is sheer folly, not least because it is sure to tempt some leisure sailors to proceed in restricted visibility when they would normally remain in the marina. Just in case you may have any lingering doubts that I am exaggerating, there is already a British company called NASA Marine manufacturing an AIS receiver (note no transmitter included!) unit for the leisure market called "AIS radar"! The product description is as follows:

The Nasa Marine AIS radar is the first stand alone AIS receiver / plotter specifically designed for the leisure boat market. The display, with ranges of 1, 2, 4, 8,16 and 32 nautical miles shows AIS carrying vessels in a format normally associated with conventional radar. A trail of previous positions clearly chows the relative track of all the targets on the screen. A box to the right of the screen displays the speed over the ground, the vessel name, mmsi number and the latidude (sic) and longitude of any target selected by the user.

The Future?

The best installations that I have seen are where there is an Electronic Navigation Chart (ENC) display adjacent to the radar. The ENC automatically displays all AIS targets and is integrated with the radar so that any radar targets being plotted are also displayed on the chart. In this way the watch keeper can concentrate on using the radar equipment for which he should have been fully trained but can also refer to the ENC for an overview of the vesselís position and can monitor and obtain extended AIS information from this secondary system without interfering with the familiar radar detail which he has been trained to use. Unfortunately there are two major problems with this arrangement. Firstly there is no requirement to carry an ENC and secondly, in contrast to the still rare officially licensed Electronic Chart display and Information System (ECDIS) which can replace the paper chart folio, the vast majority of ENC's currently in use do not meet the stringent specifications of an ECDIS for accuracy and corrections and come with the warning "Not to be used for navigation"! It is for this reason that radar has been chosen as the AIS screen display platform but I believe that with all the different radars incorporating the manufacturers (usually incorrect) ideas as to how information is accessed and presented to the user dangerous confusion will be the inevitable result of the rush to embrace AIS. However, I have been proven wrong so far so I am sure that I will be proven wrong again. I hope so!

JCB

My thanks to Dr. Andy Norris for his kind permission to use the texts included with this article.

Feedback Required

Feedback on experiences with all aspects of AIS are urgently required and reports should be sent to the dedicated "forum" link on the Nautical Institute website at: ***www.nautinst.org/ais/***

Pilots are ideally placed to provide valuable input through their experiences on a wide range of ships in varying environments. All information received is passed on to the relevant experts who will use it to identify and resolve operational problems, so please participate.

Serious errors should also be reported to the MCA on the form attached to MIN 231.

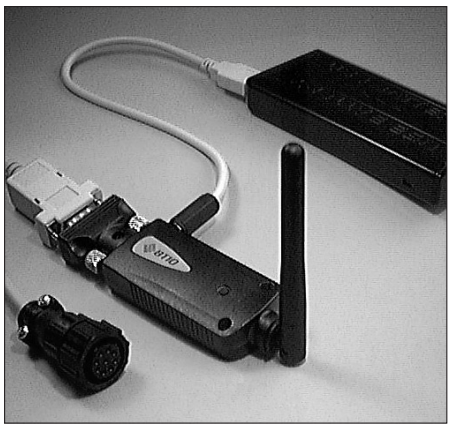
Other MCA advice on AIS is contained within MGN 277 and MSN 1975.

Y-TRONICS

Whilst I was preparing the AIS update feature I was contacted by a German company called Y-Tronics who market AIS hardware units and accessories. One item which will be of particular interest to pilots is a "Bluetooth" connector to remotely link a pilot's laptop to a vessel's AIS pilot plug. Ed Neale from Milford Haven is going to be testing this equipment on their pilot docking PDAs and laptop units so I hope to have a full report in a future issue.

Weblink:
www.y-tronic.com/english/start_en.htm

JCB



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